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In situ Rb-Sr dating applications to extraterrestrial samples

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The Rb-Sr dating system is based on the radioactive decay of ^{87}Rb in ^{87}Sr, with a half-life of ca. 49.6 Ga. Because of the general abundance of Rb in K-bearing phases such as K-feldspar, biotite, and muscovite, the Rb-Sr system has been extensively used for geochronological studies of terrestrial samples. Its application to dating extraterrestrial samples has been more challenging, for several reasons including (i) limited availability of these precious samples, making it difficult to separate sufficient amounts of mineral fractions needed for dissolution and column chemistry, and (ii) low Rb abundances in volatile-poor samples from inner Solar System materials. Also, the Rb-Sr system can be easily affected by post-crystallisation disturbances, such as impact-related metamorphism, causing partial to total resetting of the Rb-Sr chronometer. Therefore, loss of petrographic context when analysing bulk rock and mineral fractions makes it challenging to properly interpret Rb-Sr dates in these complex settings.

In situ Rb-Sr analyses using secondary ion mass spectrometry and laser ablation – inductively coupled plasma mass spectrometry (LA-ICP-MS) have long been hampered by the isobaric interference between ^{87}Rb and ^{87}Sr. The development of ICP-MS instruments equipped with collision-reaction cells in the last decade has allowed to overcome these analytical challenges. By introducing a reactive gas such as N_2O in the collision cell, it is possible to separate ^{87}Sr from ^{87}Rb as the former efficiently reacts with O while the latter does not. Thus, Sr isotopes can be measured as their mass-shifted ^{x}SrO reaction products (where x stands for 86, 87, and 88) while Rb isotopes are measured on-mass. This now allows in situ Rb-Sr dating via LA-ICP-MS, preserving key petrographic context for the phases dated.

We have been developing and improving in situ Rb/Sr dating protocols over the past few years, notably aimed at dating extraterrestrial samples. We will present some of the results obtained on Erg Cherch 002 (the oldest magmatic rock in the Solar System), on enstatite chondrite meteorites and the information this gives us on the evolution of their parent asteroids, and on a range of samples from the Moon (including anorthosites, mare basalts, and granite-like evolved lithologies).